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Power for Agricultural Purposes

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Sixty years ago the farmer realized little of the value of science. Steam was scarcely used upon the farm, and electricity was not even thought of as applicable to agriculture. The tiller of the soil in those early days, was content with a wooden plow, three-tined hoe and other equally crude implements which were made to order by the village blacksmith. He planted his seed and cultivated his crops to the best of his ability with the tools at his disposal and in accordance with what meagre knowledge he might have of agricultural problems. If the season was favorable and help plentiful, he harvested a fair crop; but if the season was unfavorable or a factory had started up in the vicinity which would pay higher wages for labor than the farmer could afford, and therefore secure nearly all the help attainable, the farmer's crops were a partial or complete failure.

To-day the well informed farmer can almost defy the elements; except perhaps in case of disastrous hailstorm, a tornado or a local flood. He has learned to surmount most obstacles. He can irrigate his fields during a drought and he can plant, cultivate, and harvest crops almost entirely by machinery; thus overcoming to a great extent the drought and scarcity of laborers.

If there happens to be no local market, he can use the railroads and water transportation to convey his produce to any part of the world where there is a demand for it.

The modern farmer must be a scientific man. He must understand the principles underlying the growth of vegetation. He must have a considerable knowledge of scientific labor-saving machinery and must know how to study the markets and to prepare his products for them.

Comparatively little has been written upon power available for farming purposes. It is a subject so suggestive and important that a short discussion of it will not be out of place.

There is scarcely a farm but could profit by the use of power to lift water for irrigating purposes at some time in the year, to thresh grain, cut hay, and roots for cattle, grind grain, saw wood or do other similar work. Upon many farms in the United States, especially here in New England, the power exists in the form of a water fall and is only waiting to be put to some profitable use; and a windmill could be used to good advantage on almost any farm where it is not necessary that the power should be continuous or available at a particular time.

It is my purpose to discuss principally two of the forms of power that are at present being studied by the progressive agricultural world, the vapor engine and electricity.

Although liquid fuel has been employed for the past thirty years for the production of mechanical energy, it is only recently that its use for this purpose has been sufficiently successful to justify an affirmative reply to the question, May a farmer use an oil engine?

Liquid fuel has been employed in the past in four different ways. First, it has been burned in the place of coal, by means of suitable spray-making devices, in the furnace of an ordinary boiler. Secondly, in one or the other of its more volatile forms such as naptha or benzine, it has been used as fuel, the boiler itself containing the same liquid, the vapor of which takes the place of steam in the engine. Thirdly, it has been evaporated at low temperature and the resulting gas, mixed with a suitable volume of air, exploded in the cylinder as in the gas engine. Finally, it has been gasified at high temperature and the resulting product, mixed with a proper quantity of air, exploded in the engine as in the former case.

These methods are all defective for various reasons. The first is costly; for, although experiment has proved that a pound of oil burned in the most advantageous way, in the furnace of a steam-boiler will evaporate some twenty-five percent more water than the same quantity of good coal, the oil costs about four or five times as much as the coal, weight for weight.

The second method is dangerous; for only the more volatile mineral oils, like naptha or benzoline, whose vapor ignites at comparatively low temperatures can be employed for the purpose. In addition, these "spirits" (rather than low oils) are not easily procurable in the country, are dangerous to handle or store, and are regarded with profound dislike by both railway and insurance companies.

The third and fourth methods involve difficulties arising from the fact that the petroleum of commerce is a compound substance whose several constituents boil at temperatures differing from one another by many degrees. When, therefore, petroleum is evaporated (as in the third method) by moderate heat, first its more volatile, and afterwards its less volatile constituents are successively vaporized, until there remains a very considerable residue which is so difficult to evaporate as to be practically useless.

When on the other hand, mineral oil is gasified by great heat (as in the fourth method mentioned) a quantity of tarry matter is produced which, passing into the engine with the gas, is deposited in the cylinder and its passages. Such deposits always seriously interfere with the operation of the engine.

One or another of the difficulties here enumerated prevented the success of the oil-engine until Etève conceived the idea of first spraying and then vaporizing the complex substance called petroleum. This plan has been successfully reduced to practice. The oil which is everywhere used for lighting, and is everywhere procurable, is at present employed. Flowing from a suitable tank, it is first converted into the finest possible spray by its passage under pressure through a suitable nozzle, or spraymaker. In this finely divided condition, it enters a heated chamber, where the oil spray is vaporized, passing thence to the engine, and becoming mixed on its way with a proper quantity of air the mixture being finally exploded in the cylinder, as in the gas-engine. The products of combustion leave the cylinder at a very high temperature, and the exhaust is utilized to maintain the required heat in the vaporizing chamber.

Under this system it is of no consequence whether the whole of the oil-spray becomes vaporized before explosion; for its particles are so minute that they are burnt in the cylinder as easily as the true oil-vapor, and the inherent difficulties in vaporization or gasification of the oil in bulk are avoided. This kind of engine thus makes use of all the hydrocarbon supplied to it without residual waste and with no production of tar; independent testimony of the most reliable knid being at hand to prove that the cylinder, valve chamber, and passages of this engine remain perfectly clear after a period of use which may be measured by several millions of revolutions. Such, then, being its present state of development, it becomes interesting to inquire more closely into the general suitability of the oil-engines for use on the farm.

A farmer's engine should economize fuel, be light in weight relative to power produced; need little skilled attention; be safe to use in any place and requiring fuel which may be readily procured, easily transported and safely stored.

The two best known types of oil-engines are the Etève and Priestman of England and the Miety and Weiss of the United States. Considering them in relation to the points above mentioned the following may be said. The Etève and Priestman engine has been run upon one pound of oil per horse-power for one hour. The Miety and Weiss Company claim that their engine will run at a cost of one cent per horse-power hour with coal at seven cents per gallon, and the machine has been credited with a considerably better performance in some cases.

The English engine above referred to developing seven and three-fourths horse-power, weighed thirty-six hundred pounds; while the American engine of eight horse power weighed only twenty-six hundred pounds.

Thanks to the extensive use of the kerosene lamp, such oil as is required by these engines is procurable everywhere, even in the most remote villages or at any cross-roads store. As is well known it is perfectly safe to transport, is handled more easily than coal and can be stored in a smaller space.

The oil-engine requires no experinced engineer or fireman. It may be set to work and then left to itself. It will continue up to the limit of its power to develop such energy as may be required without any attention other than occasional oiling.

The exhaust of an oil-engine, not being connected with any furnace, requires no cage on the chimney-top, as there are no sparks to be thrown into the air. There is no fire-box and no fire to be drawn at the end of the day's work. There is no boiler pressure, and no safety valve, and there is no possibility in cold weather of a feed pipe bursting by freezing residual water. A match is all that is required to start it and there is no time lost in getting up steam. The makers of oil-engines offer just as good guarantees regarding reliability and cost of operation as do the makers of gasoline-engines, and the description given will apply to one as well as the other except perhaps in a few minor details and the danger in handling and storing the fuel. Insurance companies dislike to assume any risk on buildings in or near which gasoline is stored. In view of all these things, then where natural power is not available for the purpose required, the oil-engine is evidently most desirable.

Considering, then, the value of the oil-engine as a power-producing agent, it is well to recognize therewith the importance of the application of electricity.

It is a well known fact that electrical science has made wonderful progress in the past twenty-five years, and to-day electricity is employed, because of its adaptability and economy, for almost every conceivable purpose. The principal uses are for heat, light, and power. Each one of these is an absolute necessity to the farmer. The main problems to be solved, then, are, Can these essentials be produced economically through the agency of electricity, and is it safe and desirable to use providing can be so produced?

If there happens to be located upon the farm a stream from which power can be procured, it can be utilized through the agency of a water-wheel and dynamo, and the energy transferred to any desired point. The first cost may prove prohibitive where power is difficult to procure or the farmer has little use for the same; but after a plant is once installed in a proper manner, the running expenses should be very small for the length of time that any one man would care to use it. If water energy cannot be utilized, and a mechanical power could be used advantageously, instead of propelling a heavy traction engine over the farm, the power-making apparatus could be placed at the edge of a field or at any convenient place. Then only the implement desired, with a light electric motor attached, would have to be moved; thereby saving the energy required to move the greater weight of the whole power-producing apparatus.

The dangers arising from the use of electricity are fires and personal injury by contact. Statistics show us that there are fewer fires caused by current electricity than by almost any other agent. As to personal injury by contact, the pressure likely to be used in this class of work would cause nothing more than an unpleasant sensation. A person would not think of putting his hand into a set of relvolving gears; but by accident it sometimes happens that they are placed there. A similar contact with wires, under the conditions herein described, would cause far less injury or pain.

An electric generator, or dynamo, is a machine constructed upon the principle that a conductor moved in a magnetic field at right angles to the lines of force, or so as to cut them, will generate an electric current in that conductor. There are two principal parts to the dynamo; the field magnets and the armature. The field magnets are composed of cores of soft iron generally bolted to the frame, but sometimes formed by the frame itself; and upon these cores are wound several coils of wire, all or a portion of the current flowing through these, making powerful electromagnets. Between these magnets there revolves an armature, which is composed of a number of coils of wire so wound upon a shaft that as it revolves, the wires will cut across the lines of magnetic force produced by the magnets. The ends of thesearmature wires are connected to copper bars arranged near one end of the shaft so that the current may be collected and led away from the machine by means of brushes fastened to the frame but insulated from it. These brushes are arranged to bear upon the copper bars as the armature rotates, collect the current generated and transfer it to the transmission line for light, heat, and power purposes.

The dynamo as now constructed needs a minimum of attention and care. It may be started and after one is certain that it is working properly, may be left, if necessary, days at a time without any attention whatever.

Motors are constructed upon the same principle as dynamos, but transform the energy in the apposite direction. A dynamo or motor is simply a machine for the transformation of energy. A dynamo receives mechanical energy and gives out electrical energy, while a motor receives electrical energy and produces mechanical energy. The same machine will work either as dynamo or motor.

The principle of the dynamo was discovered by Faraday, seventy years ago, in 1831; but it remained for the late Z. T. Gramme, who died within a few months, to make it a commercial success by the invention of his ring armature in 1870. Thus in the past thirty years the dynamo has been evolved and adapted to almost every work imaginable. It has cheapened and improved the light of municipalities and villages. It has enabled manufacturing establishments to run more profitably, has cheapened transportation, and improved transportation facilities. Such improvement carried, as it is, into the rural districts is of inestimable value to the farmer. It brings, freight, express, and passenger service, in many instances, to his very door. This enables him to ship his produce a considerable distance to market at a minimum expense. He can also obtain his groceries and other merchandise in the same way. Hartford merchants are supplying rural customers by shipping their goods on trolley expresses and paying express charges, thereby bringing the advantages of the city store right to the farmer's house. In cases where circumstances are favorable the farmer may buy power from a trolley road that passes near his farm.

Another factor which may well be considered in the employment of electricity, is the storage battery, or accumulator, as it is called. This consists of a number of cells, each made up of several lead plates immersed in a solution of dilute sulphuric acid. These plates are divided into two sets, the positive and the negative, each set being usually made up of two or more connected plates. These plates, or grids, as they are termed, are formed by a long and expensive process, which therefore makes the first cost of a battery very high as compared with the work it will do. The storage battery has proved a paying investment for lighting and street-railway companies where there is at certain times of the day, a heavy output and other times little or none. Instead of operating machinery for the full time, which is capable of taking care of the maximum load, such power may be used as will supply the average demand. The generating plant charges the accumulators when power exceeds the demand and the battery takes care of the extra load when the output exceeds the capacity of the generators.

The storage battery has a great future before it, provided its weight can be reduced and that it can be cheapened by forming the plates more rapidly. The objections can be overcome, and there are eminent men at work upon these problems, there is a wide field for its use in portable work. Think of changing the storage battery by water-power at night while the farmer is sleeping, and the next day using it to propel his vehicle many miles with power which cost very little to procure! We have heard considerable recently about the windmill and storage-battery as a desirable and economical combination for the farmer. It may do for the city man who has a country residence or for a retired farmer with whom the watchword is not necessarily "economy;" but for the average farmer, at the present stage of its development, a storage-battery would not prove a paying investment. For example, such an outfit, for lighting purposes alone would cost from $500. to $700. besides an annual expense of about $100. to $150 for interest and depreciation, which is somewhat more expensive than kerosene, even if the farmer does not own his own oil-well.

Electric power, however, has been found to be especially adaptable to farm machinery. The motors are light and compact, relatively to power produced, and are easily controlled. Electric plows are operated extensively in Germany and France and to a considerable extent in the United States. In a recent number of the "American Electrician" is described a harvesting machine, used in California, which will gather a crop of seventy-five acres of wheat and clean it for market in one day. On the mammoth western farms, where electricity can be generated cheaply by the use of water stored for irrigation, this power takes the place of all others. Wherever there is a stream of water running through the farm, it is comparatively easy to solve the problem. On streams which are dry a part of the year the water is stored up in large reservoirs to be used when needed. In one instance a turbine water-wheel drives a dynamo which develops all the power required. Wires are strung on poles to different parts of the farm to convey electricity for furnishing light, heat, and power. There are two electric motors to drive pumps for the stables, a straw and hay-cutter, a grindstone, a turning-lathe, and a large band saw capable of cutting up huge logs. There is also a larger motor for driving heavier machinery, such as a threshing machine. This motor can be located anywhere on the farm and connected up with the supply circuit through flexible leads.

Nearly all field machines have now been built for electric propulsion. With farming machinery designed for such use, the problem of applying electric power to agricultural work is reduced to the question of the utility and economy of water-power, vapor or steam engine, as the primal power, in any particular case.

An account is given in the "Rural New-Yorker" of the use of electricity on the farm of G. R. Beardsley, in Herkimer County, New York. There is a waterfall near his place where the water makes a drop of 120 feet in the East Canada Creek. An electric plant has been installed there for the purpose of supplying light and power to St. Johnsville, a little to the east. Wires were run so as to have lights in the houses and barns and a ten horse power induction motor was used to cut ensilage, to thresh, to grind feed, and to run a sawmill. A one horse power motor is also used for the milk room. This runs a separator and churn. In the house, experiments have been made with electricity for heating purposes. The electric flat irons have proved a grand success. Little stoves are also used. These attach anywhere to a lamp socket, and are a great convenience. Another excellent device is the hot pad, which is a substitute for the old hot-water bag, and is a great improvement on it. They also have two small radiators in use, which, Mr. Beardsley says, have proved very successful. He affirms that it is possible to milk by electricity, but it has not yet been done on his farm. On a farm near by, a milking machine is used, which is run by a steam engine. This apparatus milked ten cows at a time but it did not pay for the steam used. Perhaps the most remarkable part of this system is the equipment of the milk room. The arrangements there are quite complete. For instance, small bracket heaters are placed in a cupboard, where the cream is cured at any desired temperature. There is also one of the little stoves, on which a kettle is kept constantly boiling, to be used in scalding all the milk utensils. One objection often raised to the gasoline engine is that it does not provide a proper supply of hot water for dairy purposes. As will be seen this electric device meets this objection fully, as by means of the little stove a constant supply of hot water can be provided.

At a trial which was conducted in Germany as to the relative cost of different forms of power in plowing, a twelve-horse power portable engine and dynamo was used to generate electricity. The comparative cost was found to be as follows: electricity, 5.5; steam plow, 10; and plow drawn by oxen, 12.5. If electricity should show such economy when generated from fuel, think of the economy when generated by water-power.

Here is one problem which could be worked out to advantage with many farmers. Suppose there is a maximum demand for ten horses enough of the year so that a farmer would be compelled to keep that number. The cost of ten good horses would be at least $1000. The expense of keeping one horse for one year would be as follows:

Three tons of hay at $15.00	$45.00
120 bushels of grain at .40	48.00
Shoeing	15.00
Depreciation	10.00
Repair of harnesses	5.00
Total cost of keeping one horse for one year	$123.00

For ten horses there would be an annual cost of $1230.00

Now let us see what would be the expense of electric power to do the same work.

Oil engine 10 H.P.	$800.00
Dynamo 10 H.P.	240.00
Motor 10 H.P.	240.00
Motor 5 H.P.	150.00
Wire and flexible leads	250.00
Total first cost	$1680.00

Annual cost.

Interest at 6%	$96.00
Depreciation	25.00
Cost of fuel for three hundred eight-hour days	240.00
Keeping two horses for extra work	246.00
Making a total cost of	$607.00

$1230.00

607.00

Or a balance in favor of the electric plant $ 623.00

This saving in ten years would more than pay for the average New England farm. It would change some farms from an unprofitable condition to a paying basis. It would lift the mortgage on many in a short time, and there would be something of interest for the boys to keep them on the farm.

If a stream passed through the farm or near by, of a sufficient size and from which a necessary fall could be obtained, electrical power could be taken from it to heat and light the premises and supply power for any purpose. If a modern dynamo was properly installed with a good water-wheel, from 60% to 75% of the theoretical water-power could be utilized and the apparatus could be run continually with no other attention than perhaps wiping off some parts once or twice a week and oiling once a month. It would be well to look at the apparatus at least once a day, but probably it would not need mote attention than the above mentioned.

The wide-awake farmer must learn to figure these problems himself. He must be all the time seeking to find in what way he may economize and use the powers which nature has placed at his disposal. It is only by such attention that he will keep pace with the general progress and add to the commercial importance of the nation.